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## Article

# Asymmetrical effect of oil and gas resource rent on economic growth: Empirical evidence from Ghana

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## DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

# Asymmetrical effect of oil and gas resource rent on economic growth: Empirical evidence from Ghana

Opoku Adabor<sup>1\*</sup> and Emmanuel Buabeng<sup>1</sup>

**Abstract:** We investigate the asymmetric effect of oil and gas resource rent on economic growth of Ghana for the period 2010 to 2019, dwelling on the hypothesis that natural resources extraction has double-edge effect on economic growth. Using Nonlinear Autoregressive Distributed Lag (NARDL) model as estimation strategy, we find that oil and gas resource rent affect economic growth asymmetrically. Specifically, our NARDL estimates suggest that oil resource rent promotes economic growth significantly, providing empirical evidence in support of the resource blessing hypothesis. However, gas resource rent exerts a significant adverse effect on economic growth, providing empirical evidence to support the resource curse hypothesis. Our findings point to the need for policies that promote the expansion of oil resources firms than gas resource firms in the short run while long term policies should target setting up both oil and gas resource firms in developing countries, especially countries with similar socioeconomic and demographic setting like Ghana. Finally, government and monetary authorities should

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## PUBLIC INTEREST STATEMENT

The resource blessing hypothesis implies that natural resources such as oil and gas contribute significantly to sustainable economic growth while the resource curse hypothesis implies that some developing countries are genuinely rich in terms of natural resources but do not fully benefit from them since they have not been able to attain sustainable growth while other countries, similarly endowed, have attained sustainable economic growth and development. This implies that natural resources extraction have two opposing effect on economic growth and development but the extant literature in developing countries largely focused on testing the resources curse hypothesis.

We contribute to the extant literature by examining whether oil or gas resources extraction would support the resource blessing hypothesis in developing countries (Ghana specifically). We find that oil resource extraction contributes significantly to economic growth compared to gas resource extraction. Our findings suggest that more effort and policies should be geared towards oil resource extraction in developing countries since oil resource extraction supports the resource blessing hypothesis.

promote policies that attract foreign direct investment inflow in Ghana while taming inflation and lending rate towards growth enhancing targets.

**Subjects:** Economics; Macroeconomics; Monetary Economics; International Economics; Development Economics

**Keywords:** Economic growth; natural resource; gas resource rent; oil resource rent; asymmetric; NARDL and Ghana

## 1. Introduction

Natural resources are initial essential natural inputs of human society that can be obtained freely from nature for sustainable economic growth and development (Wang et al., 2021). Thus, abundance natural resources can provide the energy, food and raw materials needed for economic growth, which is relatively conducive to economic development. Natural resources contribute to economic growth and development by providing initial inputs for production and generating significant foreign revenue through their exports. Despite the relevant contributions of natural resources to economic development, the empirical relationship between natural resource rent and economic growth has received far less attention in the extant literature. Specifically, studies that focused on testing the resource blessing hypothesis in developing countries are relatively scanty in the literature. Accordingly, there is a general lack of robust studies that examine the quantitative effect of oil and gas resource rent on economic growth in Ghana. Few studies that examine natural resource rent in Ghana (Acquah, 1995; Armah et al., 2014; Kendie & Guri, 2007) lack good empirical and quantitative grounds against which to formulate and judge fiscal policy adjustment plans concerning efficient extraction of natural resources to accelerate economic growth.

Natural resources could be defined as stock of natural assets that are available in the natural environment, which are scarce in nature but economically useful in the production process or for consumption after minimal processing, in raw state or finished product (Venables, 2010). While this definition explicitly explains the imperative benefits associated with natural resources extraction (Collier & Venables, 2010), both theoretical and empirical literature argued that natural resources could be either a blessing or curse to a country. Thus, natural resources can have two opposing impact on sustainable economic growth and development of an economy. Classical economist including David Ricardo and Adam Smith developed the natural resource blessing hypothesis, which suggests that countries endowed with abundant natural resources would do well in terms of economic development as compared to countries with scanty natural resource. This hypothesis was supported by evidence from Sachs (2007) who found that oil resource rent promotes economic development through increasing consumption, investment and public budget. However, proponent of the resource curse hypothesis argued that natural resources breeds conflict, war and violence which exacerbate poverty to hinder economic growth and development (Auty, 1990; Gelb, 1988; Karl, 1997). Thus, natural resource could be a limitation to economic development.

Oil and gas resources are natural wealth or asset, which contribute immensely to economic growth and development across different countries (Badia-Miró et al., 2015; Gylfason, 2002). These natural resources are highly valuable because of their enormous impact on the economy in the form of employment, revenue contribution, social contribution and poverty reduction (Bornhorst et al., 2009; Freudenburg & Gramling, 1994; Weber, 2012). For instance, the resource sector provides employment opportunity and livelihood in poor communities via provision of infrastructure in areas where they are located. Poor individuals living in rural areas depend directly on these natural resources for survival. Natural resources also contribute to revenue generation through tax payment by firms engaged in natural resources extraction (Mawejje, 2019). Government earns part of revenue generated from natural resource extraction for infrastructure development and provision of essential social amenities such as water and electricity which promote economic growth and development (Humbatova & Hajiyev, 2019). Employees and employers working in the resource sector also earn income for consumption to improve their standard of living (Bankasi, 2017). In Ghana, natural resources contribute to about 40% of total

foreign revenue generated through their exportation. Ghana is an export driven growth economy and significant proportion of Ghana's foreign revenue is made out of exporting natural resources such as gold, crude oil, cocoa, timber, bauxite and others (Aryeetey & Kanbur, 2017). Hence, the Ghanaian economy would be weakening without natural resources exportation.

The adverse effect of natural resources on an economy manifest in the form of increase in prices of basic commodities, displacement of individuals, conflict, migration and environment pollution (Bannon & Collier, 2003; Humphreys, 2005; Nesheim et al., 2006). For instance, oil and gas production areas in Ghana have been hit with overpopulation (Asafu-Adjaye, 2010) leading to high rate of unemployment, inflation, high cost of accommodation, corruption and conflict (Plänitz & Kuzu, 2015). Natural resource extraction causes pollution and emit CO<sub>2</sub> into the atmosphere which are detrimental to once health (Acquah-andoh et al., 2018; Sakyi et al., 2012). Furthermore, proponents of "resource curse" theory postulate that the inhabitants of developing countries especially, African countries that significantly depend on natural resources are extremely poor, illiterates and unemployed (Frankel, 2011; Heller, 2006).

The study examines the effect of oil and gas resource rent on economic growth, using Ghana as a case study. We utilized monthly time series data from the World Development indicator of the World Bank and Bank of Ghana over relatively short period of 2010 to 2019. We account for the asymmetries in oil and gas resource rent using nonlinear ARDL model. Our empirical results suggest that profit/income made out of oil resource extraction promotes economic growth while cost incurred from oil resource extraction affects economic growth negatively but insignificant. These findings contradict previous studies (Cockx & Francken, 2016; Moradbeigi & Law, 2017) but support the resource blessing hypothesis. For gas resource rent, income/gains made out of gas resource extraction affects economic growth of Ghana positively but not significant while cost incurred from oil resource extraction exerts significant and negative effect on economic growth of Ghana. Our NARDL estimates also suggest that lending rate, exchange rate and foreign direct investment significantly affect economic growth of Ghana.

Our literature search indicates that most of the existing studies largely focused on testing the resource curse hypothesis in developing countries which implies that developing countries do not attain maximum benefit from natural resource extraction (Ahmed et al., 2016; Apergis et al., 2014; Apergis & Payne, 2010; Cockx & Francken, 2016; Moradbeigi & Law, 2017; Van der Ploeg & Venables, 2009). Few studies in this strand of literature also focused on testing resource blessing hypothesis, especially in developed countries (Alexeev & Conrad, 2009; Boyce & Emery, 2011; Michaels, 2011). Other studies have also examined the causal relationship between natural resource extraction and economic growth and found two different outcomes. Some studies found unidirectional causality running from oil resource extraction to gross domestic product without feedback (Apergis et al., 2014; Quixina & Almeida, 2014). other studies also found bidirectional causality between natural resource extraction and economic growth (Hamdi & Sbia, 2013b). Regarding related empirical studies in Ghana, Dah and Sulemana (2010) examined how oil production affect economic development of Ghana. The study found that oil production attracts more foreign direct investment to promote economic development. We make at least three contributions to this strand of literature. First, the outcome in the literature is mixed. Secondly, studies in Ghana that empirically test the resource blessing hypothesis are relatively scanty. Hence, the study fills this literature gap. Additionally, this study departs from previous studies in literature by examining the effect of oil and gas resource rent on economic growth to verify whether oil or gas resource extraction support the resource blessing hypothesis in developing countries. Lastly, due to the important contributions of natural resources to economic growth and development, inadequate natural resource extraction does adversely affect the social and economic development of a country. To avoid such situation, empirical studies are carried out among other effort to regulate and increase natural resource extraction over a long period.

The rest of the paper is organized as follows; overview of oil and gas production, theoretical framework/empirical studies, data and variables, model specification, estimation strategy, empirical results and conclusion.

### **1.1. Overview of oil and gas production in Ghana**

Crude oil production started in Ghana after a discovery by Kosmos Energy and Tullow oil around July, 2007 in Western Region of Ghana. However, the location was named jubilee field based on historical facts and the sudden discovery of the crude oil. Development towards jubilee field officially began in December, 2010 and was launched as a place of oil. Aside the jubilee field, another field was also discovered and named Tweneboa field (Annan, 2008). The jubilee field is located 60 km off the Coast of Ghana sharing border with the Cote d' Ivories. Tweneboa field is also 6 km off Jubilee Field and produce a significant amount of crude oil. Jubilee Field produces an average 2 or more billion barrels of crude oil per day while Tweneboa field produces about 1.4 billion barrels of oil per day (Annan, 2008). These two fields are the major source of Ghana's oil and gas production. In relation to the quality, jubilee field produces light oil indicating its high quality, hence, draws significant inflow of foreign investment into the country. Ghana currently operates one oil refinery. Thus, the Tema oil refinery which has a refinery capacity of about 45,000 barrels per day (Audit, 2019; Strategy, 2010). However, due to technical (before closure, it was operating on the average of 28,000 barrels per day) and financial challenges, the refinery is grounded and producing at zero barrel per day. Within the first quarter of production, government of Ghana was able to secure about Ghc445 million equivalents to US\$ 316 million of revenue (Strategy, 2010).

Regarding gas production in Ghana, full commercial production commenced in 2010 at the Jubilee field. The first commercial quantities produced was about 23 billion cubic feet (Asumadu-Sarkodie & Owusu, 2016). The natural gas is transmitted onshore to Atuabo natural processing facility through Kwame Nkrumah FPSO pipeline for minimal processing. After a minimal processing by Atuabo processing facility, the gas is then transported to various gas stations across the country for economic and domestic activities.

The Offshore Cape Three Points (OCTP) fields produced an average of 56,000 barrels per day (b/d) which is expected to increase to 64,000 b/d in 2018. It was expected to reach a peak level of 45,000 b/d production in 2019 but could not reach this peak. As result, the current and previous production capacity could not meet domestic gas need. Ghana import significant proportion of natural gas from Nigeria through West African Gas Pipeline (WAGP) likely due high domestic demand for gas. Due to Ghana's failure to meet its debt repayment obligations and feedstock constraints, import of gas through WAGP has become inefficient and unreliable in nature. As a result, WAGP suspended export of natural gas to Ghana temporary in June 2006 (Asumadu-Sarkodie & Owusu, 2016).

Due to the unreliable pipeline gas importation from neighboring countries, the government of Ghana turned to liquefied natural gas as a means to accommodate the increasing domestic demand for natural gas. However, the government of Ghana failed to meet the domestic demand for liquefied natural gas (LNG), likely due to lack of proper infrastructure through which the natural gas would be imported from the rest of the world. For instance, poor onshore port infrastructure delayed a deal to acquire and use Golar Tundra LNG terminal, a floating storage and regasification unit (FSRU) that was delivered to Ghana in May 2016. Additionally, Ghana received \$23 million from West African Gas Limited (WAGL) via a vessel but the vessel left Ghanaian waters in 2017 due to poor onshore infrastructure facilities (Asumadu-Sarkodie & Owusu, 2016).

### **1.2. Theoretical framework/ empirical studies**

Natural resource rent is an economic profit or surplus value that accrue to firms (shareholders and government included) after accounting for cost of production (factors of production specifically) and opportunity cost of producing the resource, above the marginal cost essentially (Van der Ploeg, 2011). The returns from natural resource rent is highly unpredictable because the returns could be high (abnormal profit), low (normal profit), zero (break-even) or negative (loss), hence,



their impact on economic growth vary across different countries. The classical economists believe that natural resources are the main contributors of sustainable economic growth and development. Hence, countries endowed with abundance rich natural resources would do well in terms of economic performance (resource blessing hypothesis). However, this traditional view of natural resource rent that it mitigates poverty, unemployment and income inequality to improve economic growth and development has been challenged by past empirical studies (Moradbeigi & Law, 2017; Van der Ploeg, 2011, 2006). This brought about the famous phenomenon of “resource curse hypothesis” in developing countries (Badeeb et al., 2017).

The resource curse phenomenon also known as the paradox of plenty or the poverty paradox refers to inability of many resource-abundance countries, especially developing countries to fully benefit from stock of natural assets or wealth (such as fossil fuel, gas and other minerals) available freely in the environment (Atkinson & Hamilton, 2003; Fleming et al., 2015). These natural resources generate revenue for government in resource-rich countries to respond effectively to the welfare needs of the citizens. After a country discovers natural resources, one might expect to see a better growth and development outcome for such a country, however, resource abundant countries tend to experience higher rates of war, authoritarianism, conflict and macroeconomic instability compared to non-resource rich countries (Paine, 2016; Wick & Bulte, 2006). For instance, since 1990 oil rich developing countries such as Niger Delta, Iraq, Angola, Libya and Democratic Republic of Congo have experienced frequent civil war as compared to non-oil-rich countries (Williams, 2011; Yoo, 2003). This is likely to hurt the other sectors of oil rich developing countries, especially the goods and service sector to hinder the economic development of these countries.

The most famous example of the resource curse hypothesis is the “Dutch disease”. The Dutch disease is a phenomenon where oil, gas, agricultural commodities and other minerals booms have some potential negative effect on other sectors of economy, especially the goods and service sector which mitigate economic progress (Davis, 1995). Thus, substantial increase in natural resource revenue can impede the performance of the other sectors of the economy via exchange rate appreciation, increasing inflation and switching capital and labour from non-oil firms to the oil firms. The Dutch disease is well known in the literature, which was motivated by the unpleasant impact of huge natural gas discovery by the Dutch around the late 1950’s in Groningen (Papyrakis, 2017). The Dutch sought to tap this resource in an attempt to export the gas for profit. However, when the Dutch began to export the gas out of their country, it began to hurt their economy through the appreciation of domestic currency, crowding out the non-resource sectors, increase in price of non-tradable goods (housing specifically), shift of land and labour from non-oil sector to oil sector, current account deficit and substantial public debt burden (Reader, 2015).

In the literature, numerous seminal empirical studies have provided empirical evidence to support the resource curse hypothesis (Adabor & Buabeng, 2021; Ahmed et al., 2016; Apergis et al., 2014; Butkiewicz & Yanikkaya, 2010; Cockx & Francken, 2016; Moradbeigi & Law, 2017; Papyrakis & Gerlagh, 2007; Van der Ploeg & Venables, 2009). Contrary, other studies found that natural resources are blessing to a country which promote economic growth (Alexeev & Conrad, 2009; Boyce & Emery, 2011; James, 2015; Lederman & Maloney, 2006; Michaels, 2011). Additionally, based on meta-analytical approach, Havranek et al. (2016) reviewed several existing literature and found that fourty percent  $\frac{2}{5}$  of the empirical researched published within the last two decades argued that natural resources are curse to a nation while twenty percent  $\frac{1}{5}$  also suggested that natural resources are blessings to a country. However, fourty percent  $\frac{2}{5}$  of the total published articles found no evidence for the effect of natural resources on economic growth. The mixed results in literature can be attributed to several reasons including different methodologies employed, different means of measuring natural resources and different set of variables used as control variables.

Recent empirical studies have also focused on examining the causal relationship between natural resource and economic growth using different estimation techniques. Some studies employed the Granger causality approach to examine the causality between natural resources rent and economic growth. For instance, Quixina and Almeida (2014) investigated the causality amongst oil revenue, non-oil gross domestic product and financial development and found two main outcomes. First, the study identified unidirectional causality running from oil revenue to non-oil gross domestic product and financial development in Angola, respectively. Secondly, they also found no causal relationship between financial development and economic growth in Angola. Additionally, Apergis et al. (2014) used the same estimation strategy and found a negative reverse causality between agricultural value added and oil rent in oil-producing countries in the Middle East and North African countries. Hosseini and Tang (2014) also examined the effect of oil and non-oil export on economic growth of Iran using time series data from International Financial Statistics (IFS), World Development Indicators (WDI) and the Central Bank of Iran Republic (CBI). The results from the granger causality test revealed a unidirectional causality from oil and non-oil exports to economic growth.

Among studies that used the Vector error correction model as an estimation strategy, Hamdi and Sbiba (2013b) found a bidirectional causality between natural resource rent and economic growth. Their finding provided empirical evidence to support the resource blessing hypothesis. In the same vain, a study by (Hamdi & Sbiba, 2013a) in Bahrain found an empirical evidence in support of the resource blessing hypothesis. Thus, the study found a unidirectional causal relationship running from abundance natural resource extraction to economic growth using the Granger causality approach.

A number of empirical studies have also examined the impact of oil and gas production on economic growth in developing countries. Specifically, Acquah-andoh et al. (2018) investigated how oil and gas production affect economic growth of Ghana's economy, using ordinary least squares (OLS) regression as estimation strategy. The study found that current petroleum production does not increase Ghana's GDP growth. This finding is consistent with the findings of Uwakonye et al. (2006) who did a similar study in Nigeria. Cantah and Asmah (2015) also did a similar study on the relationship between crude oil price and economic growth of Ghana. The results from their study revealed that an increase in oil price had a negative and significant effect on economic growth. This results was not statistically different from that of Oduro (2017) who also examined the nexuses amongst oil consumption, oil price volatility and economic growth. Ekperiware and Olomu (2015) also employed VAR as estimation strategy to examine the effect of oil and gas production on economic growth of the agriculture sector in Nigeria. The study found a positive and significant relationship between gas production and economic growth as well as oil production and economic growth in Nigeria. Similarly, Akinlo and Apanisile (2015) also examined the relationship between oil price productivity and economic growth in oil exporting and non-oil exporting countries. The study found that oil price volatility had a positive and significant effect on economic growth for oil exporting countries. However, for non-oil producing countries, the effect was negative.

Other studies also focused examining how oil and gas production affects economic development and other macroeconomic variables. For instance, Eder et al. (2018) investigated how oil and gas exploration and production affect economic development, using fixed effect, random effect and pooled ordinary least regression as estimation technique. The study found that production of oil and gas resources in the Arctic regions exert positive effect on the level of socio-economic development in these regions. This finding is consistent with that of Humbatova and Hajiyev (2019) who did a similar study in Azerbaijan. Dah and Sulemana (2010) did a similar work on how oil production affects economic development of Ghana. The study found that natural resource attracts more foreign direct investment in Ghana. Plänitz and Kuzu (2015) also investigated the benefits associated with oil and gas production in Ghana. The study administered questionnaires to managers of thirty (30) oil and gas firms in Ghana for their responses. The study found that oil and gas production enhances government's revenue, infrastructure and fiscal development, enhances foreign exchange and creates more jobs in Ghana. These findings were consistent with the findings of Wang (2018) who did a similar study in Permian Basin.



Existing studies in developing countries mainly focused on testing the resources curse hypothesis (Adams et al., 2019; Ayelazuno, 2014; Basedau, 2005; Hammond, 2011; Sala-I-Martin & Subramanian, 2013). Relatively speaking, much less is known on testing the existence of the resource blessing hypothesis in developing countries, especially in Ghana. To fill this gap in literature, we conduct a robust analysis on how oil and gas resource rent affect economic growth in Ghana where empirical evidence appears to be very scanty. In our analysis, we apply the appropriate methodology to avoid biasness and inconsistency in our estimates/results/findings. Although our empirical findings are for Ghana, our findings would be relevant for developing countries with similar socioeconomic and demographic setting like Ghana. This shows that our findings/results are significant beyond Ghana's boundaries. The current study also adds to the scant literature on the resource blessing hypothesis by using recent data (2010–2019) to analyze the effect of oil and gas resource rent on economic growth of Ghana in a more contemporary era.

## 2. Data and variables

The study utilized monthly time series data spanning from 2010 to 2019 from two different sources. Specifically, we obtained data on gross domestic product, foreign direct investment, gas resource rent and oil resource rent from world development indicators (WDI) of the World-Bank (2019) and data on lending rate and exchange rate were obtained from Bank of Ghana (2019). The study used 2010 as a starting point due to the fact that 2010 is the period where Ghana began its first commercial extraction of crude oil and natural gas in significant quantities (Gyampo, 2011). The description and definition of all the variables used in the study are presented in Table 1.

## 3. Model specification

The study followed previous studies (Adabor & Buabeng, 2020; Adabor et al., 2020; Buabeng et al., 2019a, 2019b; Cantah & Asmah, 2015) and specify the effect of natural resource (oil and gas resource rent specifically) on economic growth in a functional form as follows:

$$GDP = f(OR, GR, FDI, EXCR, LR, \dots) \quad (1)$$

Where GDP is gross domestic product, OR is oil resource rent, GR is gas resource rent, FDI is foreign direct investment, EXCR is exchange rate and LR lending rate.

The estimable form of equation (1) is thus specified in equation (2).

$$\ln GDP_t = \beta_0 + \beta_1 \ln OR_t + \beta_2 \ln GR_t + \beta_3 \ln FDI_t + \beta_4 \ln EXCR_t + \beta_5 \ln LR_t + \mu_t \quad (2)$$

Where the variables GDP, OR, GR, LR, FDI and EXCR are explained earlier in equation (1).  $\beta_0$  is the constant term and  $\mu_t$  is the disturbance term. The parameters  $\beta_i$ s ( $i = 1, 2, \dots, 5$ ) are the coefficient of the respective variables.

## 4. Estimation strategy

The ARDL model by Pesaran et al. (2001) assumes a linear relation between the dependent and independent variables. The ARDL model does not account for the asymmetries in the movement of the independent variables. Thus, ARDL assumes that natural resource rent (oil and gas resource rent) changes has symmetric or linear effect on economic growth. However, due to the potential asymmetric relationship between natural resource rent (oil and gas resource rent) and economic growth, the study adopted the nonlinear ARDL model (Shin et al., 2014). Thus, we estimated the parameters in equation (2) with nonlinear autoregressive distributed lags model (NARDL). To do this, we first carried out a test for stationarity among all the variables to verify if the variables are stationary or not. We employed the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) test proposed by Dickey and Fuller (1979) and Phillips and Perron (1988), respectively, to test for the stationarity among all the variables. This test aimed at determining whether the series are stationary or non-stationary (have unit roots or not) since using non-stationary time series data

**Table 1. Brief description of variables**

Variable	Description	Expected Effect
<b>Oil resource rent (OR)</b>	Oil rent is measured as average difference between the monetary value/price of crude oil production on the world market and cost of producing oil multiplied by the total volume of oil produced domestically (World-Bank, 2019). Simply put, oil resource rent is the difference between revenue earned from oil production less total cost of extracting the oil from nature. Based on this measurement, oil resource extraction can generate revenue or cost depending on cost of production and price of oil on the world market. Revenue generated out of oil resource extraction is shared among the resource extracting firm, shareholders and government based on legal agreement/contract.	?
<b>Gas resource rent (GR)</b>	The study defines gas resource rent as the difference between the monetary value/price of natural gas production at world market and total costs of producing gas domestically (World-Bank, 2019). Thus, gas resource rent is the average difference between the revenue/income earned from gas production and cost of producing total volume of gas. Natural gas extraction can generate revenue or cost depending on cost of production and price of natural gas on the world market. Revenue generated out of natural gas extraction is shared among, shareholders, government and the firm extracting the gas resource based on legal agreement/contract.	?
<b>Foreign direct investment (FDI)</b>	FDI is a category of cross border investment made by non-resident (foreigners) in an economy. Alternatively, it is defined as investment made by investors or individual into business interests area in another country.	Positive
<b>Lending rate (LR)</b>	Lending rate is the rate at which financial organizations and banks charge for giving out money to individuals, firms and small-scale enterprises. In Ghana, the average lending rate is determined by commercial banks. Hence, the commercial banks monthly base rate in Ghana was used as a proxy for the market lending rate.	Negative

(Continued)

Variable	Description	Expected Effect
<b>Economic growth (GDP)</b>	This consists of consumer spending, investments, expenditure by the government and exports less imports adjust for inflation. Alternatively, it is defined as the total amount of goods and services produced in an economy in a given period of time, usually a year (Buabeng et al., 2021).	
<b>Exchange rate(EXR)</b>	This can be expressed as the rate at which one country's currency can be traded for another country's currency. It is the price of a country's currency in terms of another country's currency.	Negative

could lead to spurious regression results which can mislead findings. The NARDL bounds test for stationarity is based on the assumption that the variables are either integrated of order zero [I (0)] or order one [I (1)] series.

The NARDL model is efficient and performs well in small sample as well as able to account for endogeneity among all the variables. It is applicable in mixed order of integration and can effectively handle pre-testing bias. The effect of natural resource rent on economic growth is asymmetric as it could be negative when the cost of producing the natural resources exceeds the revenue obtained from the natural resource extraction (loss). It could also has a positive effect on economic growth when cost of producing natural resource is less than the monetary value of natural resource on the world market (profit/gain/income). Thus, there are some periods where income earned from natural resources extraction is greater/above cost of extraction and periods in which it is below. The study filtered the losses from profit and evaluated their separate effect on economic growth. Thus, the effect of natural resource rent (oil and gas resource specifically) on economic growth might be asymmetrical. Hence, we employed the nonlinear ARDL model as an estimation strategy. We then decomposed natural resource rent into positive (profit) and negative (loss) partial sums as follows:

$$\ln NR = \ln NR_0 + \ln NR_t^- + \ln NR_t^+ \quad (3)$$

Where  $NR$  is natural resources rent (oil and gas resource rent).  $NR$  and  $\ln NR_t^-$  denote partial sum of the positive and negative changes in  $\ln NR$ , respectively. These partial sums of  $\ln NR$  are defined formally as follows:

$$\ln NR_t^+ = \sum_{i=1}^t \Delta \ln NR_i^+ = \sum_{i=1}^t \max(\Delta \ln NR_i, 0) \quad (4)$$

$$\ln NR_t^- = \sum_{i=1}^t \Delta \ln NR_i^- = \sum_{i=1}^t \min(\Delta \ln NR_i, 0) \quad (5)$$

Equation (4) and (5) were used to derive the nonlinear growth model. This is done by substituting equation (4) and (5) of the natural resource rent in the original ARDL model to arrive at the following nonlinear ARDL model for natural resource (Shin et al., 2014):

$$\begin{aligned} \ln \Delta GDP_t = & \alpha_0 + \sum_{i=1}^{p1} \beta_1 \Delta \ln GDP_{t-i} + \sum_{i=1}^{p2} \pi_1 \Delta \ln EXR_{t-i} + \sum_{i=1}^{p3} \eta_1 \Delta \ln FDI_{t-i} + \\ & \sum_{i=1}^{p4} \gamma_1 \Delta \ln LDR_{t-i} + \sum_{i=1}^{p5} \lambda_1 \Delta \ln NR_{t-i}^+ + \sum_{i=1}^{p6} \varphi \Delta \ln NR_{t-i}^- + \delta_1 GDP_{t-1} + \delta_2 \ln EXR_{t-1} + \\ & \delta_3 \ln FDI_{t-1} + \delta_4 \ln LDR_{t-1} + \delta_5 \ln NR_{t-1}^+ + \delta_6 \ln NR_{t-1}^- + \varepsilon_t \end{aligned} \quad (6)$$

In equation (6), the partial sums of Positive and Negative are the nonlinearity in model. However, we can conclude that natural resource rent changes have symmetric (linear) effect on economic growth if the coefficient of the Positive and Negative have the same size and sign. If the sign and size are different, then we can conclude that the effect of natural resources changes on economic growth is asymmetric. The long-run effect are obtain by setting the non-first-difference lag component of equation (6) to zero and normalizing  $\delta_1$ ,  $\delta_2$  and  $\delta_6$ . Following NARDL by Shin et al. (2014) we also applied the bound test by Pesaran et al. (2001) to examine the long run relationship between the dependent and independent variables. The  $p1$ ,  $p2$ ,  $p3$ ,  $p4$ ,  $p5$  and  $p6$  are the optimal lag selected through Akaike Information Criterion. We restrict the lag length to a maximum lag of 2 to save the degree of freedom, which also best fit data with low frequency like yearly, quarterly and monthly data (Perron, 1989) .

Finally, the study conducted a series of diagnostic test to ensure that the results obtained are reliable. Specifically, the study conducted normality test, serial correlation test, heteroskedasticity test, functional test and the stability test. The normality and serial correlation test were conducted using the Jarque-Bera test and the Breusch-Godfrey LM test respectively. Heteroskedasticity and functional test were conducted using Breusch-Pagan-Godfrey test and Ramsey reset test, respectively. Finally, the stability of the model over the sample period is ascertained from the plots of CUSUM and CUSUMSQ.

## 5. Empirical results

The empirical results of the study are presented in the following sequential order in this section. First, we present a summary of descriptive statistics of all the variables used in the study, followed by the results from the unit roots and the co-integration bound test. Next, we present the long- and short run estimates from the nonlinear ARDL and the diagnostic test results.

From Table 2, the series have 108 observations representing monthly time series data spanning from 2010 to 2019. While the mean depicts the average of the series, the standard deviation indicates the deviation of the series from their actual mean. Most of the variables showed a little variation or deviation from their individual means. Thus, the extent to which gross domestic product, oil rent, gas rent, foreign direct investment and exchange rate deviated from the individual means are not substantial except lending rate. Gross domestic product recorded an average of 5.3457 over the period of 2010 to 2019, while oil resource rent recorded an average of 1.9529. The maximum value that gross domestic product can attain is 14.0471 and its minimum value is 0.0128, while the maximum value of oil resource rent is 5.6721 and the minimum value is 1.0128. Furthermore, gas resource rent also recorded an average of 1.0042 within the period 2010 to 2019, while foreign direct investment also had an average of 4.2182 within the same period. Lending rate was found to have a maximum of 15.3081 and a minimum of 7.0694 while foreign direct investment had a maximum of 9.5081 and a minimum of 0.2513. The results for exchange rate follow the same interpretations.

In this section, we used the Pearson correlation as estimation strategy to examine the linear association among the main variables. The results are displayed in Table 3. Our Pearson correlation estimates suggest that there is a significant and positive relationship between oil resource rent and gross domestic product. The strong correlation value of 0.765 between oil resource rent and gross domestic product implies that when oil resource rent increases, gross domestic product of Ghana also increases. We also found a strong negative correlation between gas resource rent and economic growth of Ghana. The significant correlation coefficient of  $-0.712$  between gas resource rent and economic growth implies that when gas resource rent goes up, economic growth would also go

**Table 2. Descriptive statistics of the variables**

Variable	Observation	Mean	Std. Dev.	Min.	Max.
LnGDP	108	5.3417	2.5683	0.0128	14.0471
LnOR	108	1.9529	1.8990	1.0128	5.6721
LnGR	108	1.0042	0.0123	1.9637	4.0853
LnFDI	108	4.2182	3.2269	0.2513	9.5170
LnLR	108	10.6339	2.0620	0.2513	15.3081
LnEXR	108	1.1366	1.2193	2.9246	7.0694

Source: Author's elaboration based on World Bank and Bank of Ghana data. The table report standard deviation, mean, maximum and minimum values of all the variables used. The observations are monthly time series data spanning from 2010 to 2019. Std.Dev, Min. and Max. represent standard deviation, minimum and maximum respectively.

**Table 3. Pearson correlation coefficient estimates of the main variables**

	lnGDP	lnOR	lnGR
lnGDP	1		
lnOR	0.765***	1	
lnGR	-0.712***	0.001	1

Note: \*\*\*, \*\*, and \* implies correlation between the variables is significance at 1% (2 tailed), 5% (2 tailed) and 10% (two tailed) respectively.

down. Thus, there is an inverse association between gas resource rent and gross domestic product. Lastly, our results suggest no association between oil resource rent and gas resource rent since the correlation coefficient between these two variables was found to be 0.001. This result provides strong econometric grounds for the inclusion of both oil and gas resource rent in a single equation.

## 6. Unit root test result

In this section we present the estimates from Augmented Dickey Fuller and Philip-Perron (PP) tests. The results are reported in Table 4 above. We found that oil resource rent (OR), foreign direct investment (FDI) and exchange rate (EXR) attained stationarity at first difference. However, gross domestic product (GDP), gas resource rent (GR) and lending rate (LR) were stationary at their levels. Thus, oil resource rent, foreign direct investment and exchange rate were all integrated of order one I (1) series whiles gross domestic product, gas resource rent and lending rate were integrated of order zero I(0) series. Hence, the study can apply the bounds test to examine the long relationship among the variables.

## 7. Co-integration bound test results

The main aim of this section is to examine the long run relationship between the dependent and independent variables. The study used the bounds test approaches to co-integration as a strategy, the result are reported in Table 5. We found that the F-statistic value of 9.74839 ( $F_{GDP} = 9.74839 > 3.01$  and 3.38) exceeds the upper bound critical value of 3.01 and 3.38 at 1% and 5% level of significance, respectively. Thus, based on the bound test estimates, we concluded that gross domestic product, exchange rate, oil resource rent, gas resource rent, foreign direct investment and lending rate are co-integrated. Thus, there is a long-run relationship among the variable.

## 8. Estimated long- and short-run results using NARDL

Table 6 presents the estimated long run regression results from the NARDL. The coefficients of oil resource rent (lnOR) and gas resource rent (lnGR) revealed an asymmetric effect of natural resource rent on economic growth of Ghana.

**Table 4. Unit root estimates for both the (ADF) and (P-P) test**

	ADF test with intercept			PP test with intercept		
Variables	Level	1 <sup>st</sup> difference	I(d)	Level	1 <sup>st</sup> difference	I(d)
lnGDP	-4.0766**	-6.574***	I(0)	-3.611*	-6.562***	I(0)
lnOR	0.687	-4.117**	I(1)	-1.155	-4.185**	I(1)
lnGR	-5.606**	-3.005*	I(0)	-5.111**	-2.423*	I(0)
lnFDI	-0.648	-4.342***	I(1)	-0.581	-4.315**	I(1)
lnLR	-3.717**	-3.349**	I(0)	-3.586**	-7.301***	I(0)
lnEXR	-4.349**	-4.349**	I(1)	-1.556	-3.943**	I(1)

Source: Authors elaboration based WDI and Bank of Ghana data. Augmented Dickey Fuller and Philip-Perron (PP) tests results for all the variables used in our analysis. Note: \*\*\*, \*\*, and \* represent significance at 1%, 5% and 10% respectively.

We examine the asymmetric effect of oil and gas resource rent on economic growth by distinguish between the values in which cost of extracting oil and gas resource is above the value or price of oil and gas resource on the world market (loss) and those in which the cost of extraction oil and gas

**Table 5. Bounds test estimates**

Dependent variables	F-statistics	K = 5	
F <sub>GDP</sub> (GDP OR, GR, FDI, LR, EXR)	9.74839		
Critical Value		Lower bound	Upper bound
1%		2.11	3.01
5%		2.39	3.38

Source: Authors elaboration-based WDI and Bank of Ghana data. ARDL bound test results where K denotes the number of regressors in the equation. Lower and upper-bound critical values were obtained from Pesaran et al. (2001)

**Table 6. Long-run estimations using the NARDL**

Variable	Coefficient	Std. Error	T-Statistic
lnOR <sup>+</sup>	0.2620***	0.0490	5.3469
lnOR <sup>-</sup>	-0.4330	0.5410	-0.8004
lnGR <sup>+</sup>	0.2428	0.0619	3.9224
lnGR <sup>-</sup>	-0.5470**	0.0956	-5.7217
lnGR <sup>-</sup>	-0.3142**	0.0561	-5.6107
lnFDI	0.2459**	0.0738	3.3319
lnLR	-0.3661***	0.0867	-4.2226
Constant	1.2860***	0.2442	5.2657

Note: The dependent variable is gross domestic product (GDP) and the variables of interest are oil resource rent (OR) and gas resource rent (GR). Our control variables include exchange rate, foreign direct investment and lending rate. lnOR<sup>+</sup> represents revenue made out of oil resource extraction while OR<sup>-</sup> denotes incurring cost/losses out of oil resource extraction. The symbols for gas resource rent (lnGR<sup>+</sup> and lnGR<sup>-</sup>) are interpreted in the same manner. \*\*\* represents significant levels 1%, \*\* represents 5% and \* represent 10% level of significance.



resources is less than the price of oil and gas resource on the world market (income). Our NARDL long-run estimates empirically confirms an asymmetric effect of natural resource rent (oil and gas resource rent specifically) on economic growth of Ghana. Thus, both oil and gas resource rent had an asymmetric effect on economic growth of Ghana in the long-run. This is so because the coefficient of  $\ln OR^+$  and  $\ln OR^-$  have different signs and size. Also,  $\ln GR^+$  and  $\ln GR^-$  have different size and sign, supporting the asymmetric effect of natural resource rent on economic growth. Our results revealed the different direction of the effect of cost and profit (gain/benefit) of natural resource rent on Ghana's economic growth, which is consistent with the findings of Bahmani-Oskooee et al. (2017) who examined the asymmetric effect of exchange rate on money demand. Specifically, income (gain/benefits) made out of oil resource rent ( $\ln OR^+$ ) had a significant positive effect on gross domestic product ( $\ln GDP$ ). Thus, one percent increase in income made out of oil resource rent generates 0.262% increase in gross domestic product, all else equal. The finding implies that when firms cost of producing/extraction oil is less than the monetary value of oil on the world market, firms make income/profit. The income is shared amongst the firm, shareholders and the participating government based on agreement/contract. If firms decide to reinvest their income/profit made out of oil resource extraction via purchasing new machinery, hiring new workers and others to expand their scale of production, it would result in increasing firm's output produced to promote economic growth. Additionally, making profit/income out of production could inspire firms to increase employee's income, which tends to increase their standard of living with a resultant increase in workers productivity. Firms can also hire new workers and acquire new capital (new technology) from revenue/profit made out of oil resource extraction to increase output produced which tends increase their market power/share on the global market. The participating government earns part of the income/revenue made out of oil resource extraction to fund its developmental projects. Thus, government make revenue from oil resource extraction to finance government policies and infrastructure projects such as roads, railways, rural electrification, building of school and hospitals across the country. For instance, part of the Ghana's oil revenue is used to fund the free senior high school program in Ghana (Adam, 2017).

Contrary, loss from oil resource rent [ $\ln OR^-$ ] exerts a negative and insignificant effect economic growth of Ghana. Thus, one percent increase loss incurred out of oil resource extraction leads to 0.433% decrease in economic growth but the effect is not significant in Ghana. The economic implication of this finding is that, when cost of producing oil is greater than the value oil or the monetary value of oil on the world market, firms incur losses. When firms incur losses, it reduces employment and investment since firms cannot expand their scale of production nor hire new workers to increase production, which does not induce economic growth. Hence, Oil exporting firms become less competitive on the global market. This also reduces government spending in the economy since the participating government also earns significant part of the income made out of oil production. Thus, government cannot make enough revenue from oil production to fund developmental project in the economy which hinders development. This result contradict the finding of Acquah-andoh et al. (2018). Overall, since our NARDL estimates suggests that revenue made out of oil resources extraction significantly promotes economic growth while loss incurred out of oil resource extraction exerts an insignificant negative effect on economic growth, implying that oil resource extraction in Ghana supports the resource blessing hypothesis.

Regarding gas resource rent, an increase in income/gains ( $\ln GR^+$ ) from gas resource rent exerts positive and insignificant effect on economic growth of Ghana while loss ( $\ln GR^-$ ) from oil resource rent exerts positive and significant effect on economic growth at 5% level of significance. Specifically, an increase in gains/income made out of gas resource extraction leads to 0.243% insignificant increase in economic growth while an increase in loss incurred out of gas resource extraction generates 0.547% significant decrease in economic growth of Ghana. The economic implication of this result is that profit made out of gas production does not significantly induce economic growth in Ghana. This is so because significant proportion of liquefied petroleum gas supplied and used domestically in Ghana is mainly imported from foreign countries, hence, revenue made out of gas production in Ghana is repatriated to foreign countries. Thus, the government of Ghana does not

make adequate revenue from gas production in Ghana since substantial percent of gas used in Ghana is imported from foreign countries. Therefore, significant proportion of revenue made from gas production are not spent or invested in Ghana's economy. This does not promote economic growth. Overall, since our NARDL estimates suggests that revenue from natural gas resources extraction exerts an insignificant positive effect on economic growth while loss incurred out of gas resource extraction exerts significant negative effect on economic growth, implying that gas resource extraction in Ghana supports the resource curse hypothesis.

Turning to the control variables, the coefficients of exchange rate, foreign direct investment and lending rate exert a significant negative, positive and negative effect on economic growth of Ghana, respectively. For exchange rate, one percent depreciation of Ghana cedis causes approximately 0.314 percent decrease in economic growth (gross domestic product), reflecting the weakness of Ghana cedis. The economic implication of this result is that the depreciation of the Ghana cedis decreases the importation of foreign goods and raw materials needed for local production as these goods becomes relatively expensive. Decrease in input (raw materials) needed for production would decrease output produced by firms thereby reducing output on the local market, decreasing total gross domestic product. This result is comparable to that of Hosseini and Tang (2014). Regarding foreign direct investment, one percent increase in foreign direct investment generates approximately 0.246% increase in economic growth of Ghana, all things being equal. Foreign direct investment inflow increases infrastructure development including expansion and extending of roads networks to rural areas, increase in public health coverage and extension of electricity supply to rural areas of Ghana. Additionally, it tends to leads to expansion of local exiting firms and setting up of new multinational firms to promote economic growth. Lastly, for lending rate, the negative coefficient of  $-0.366$  implies that one percent increase in lending rate causes 0.366 percent decrease in economic growth of Ghana in the long-run, all else equal. The economic implication of this finding is that higher lending rate increase the cost of borrowing from commercial banks which reduces firm's investment and consumer's disposable income. This limits firm's ability to expand their scale of production and reduces consumer's purchasing power thereby reducing total gross domestic product of Ghana. Our finding is similar to Njeru (2013) empirical results in Nigeria. The next section provides the short-run estimates using the NARDL.

**Table 7. Estimated short-run results**

Variable	Coefficient	Std. Error	T-Statistic
$\ln OR^+$	0.3945**	0.0550	7.1727
$\ln OR^-$	-0.2965	0.0669	-4.4319
$\ln GR^+$	-0.5565	0.0559	-9.9553
$\ln GR^-$	0.4488**	0.0641	7.0015
$\ln EXR$	-0.4100***	0.0719	-5.7024
$\ln FDI$	0.1608***	0.0199	8.0804
$\ln LR$	-0.3169***	0.0498	-6.3634
ECM (-1)	-0.4943 ***	0.0718	-6.8844
R-square	0.8938		
Adjusted R-square	0.6693		
Durbin-Watson test	3.0289		
F-statistic	6.7175		
Prob (F-statistics)	0.0013		

Note: The dependent variable is gross domestic product (GDP) and the variables of interest are oil resource rent (OR) and gas resource rent (GR). Our control variables include exchange rate, foreign direct investment and lending rate.  $\ln OR^+$  represents revenue made out of oil resource extraction while  $OR^-$  denotes incurring cost/losses out of oil resource extraction. The symbols for gas resource rent ( $\ln GR^+$  and  $\ln GR^-$ ) are interpreted in the same manner. \*\*\* and \*\* represent significance at 1 and 5%, respectively.

**Table 8. Model diagnostic and reliability test results**

Diagnostic test	Test statistics	Prob. value
Normality	0.1330	0.5880
Serial correlation	1.0394	0.3969
Heteroskedasticity	1.7095	0.1950
Functional form	0.4897	0.825
CUSUM	Stable	
CUSUMQ	Stable	

The short-run results were not different from that of the long-run regarding their relationship with the dependent variable as shown in Table 7. In the short-run, we find that oil and gas resource rent have an asymmetric effect on economic growth of Ghana. Thus, the coefficient of  $\ln OR^+$  and  $\ln OR^-$  as well as  $\ln GR^+$  and  $\ln GR^-$  had different sign and size, confirming the asymmetric effect of oil and gas resource rent on economic growth. Specifically, our NARDL estimates suggest that income/profit from oil resource rent exerts a significant and positive effect on gross domestic product ( $\ln GDP$ ) while loss incurred out of oil extraction exerts an insignificant and negative effect on economic growth of Ghana. For gas resources rent, an increase in income made out of gas resource rent exerts a positive and insignificant impact on economic growth of Ghana while loss incurred from gas resources extraction exerts a negative and significant effect on economic growth of Ghana at 5% level of significance.

Regarding the control variables, they were also consistent with the long run estimates in terms of their signs and significant level. The coefficient of foreign direct investment suggests that it exerts positive and statically significant effect on economic growth at one percent level of significance. Specifically, one percent increase in foreign direct investment results in 0.16% increase in economic growth, holding all other variables constant. For exchange rate, it also had a negative and significant relationship with economic growth of Ghana. Thus, when the country's currency experience one percent depreciation, economic growth would decrease by 0.41 percent, all else equal. The decrease in economic growth is likely due to the fact that depreciation of the currency make importation of raw materials and machinery very expensive, decreasing workers productivity. Lastly, the short-run NARDL estimates revealed that lending rate had a negative and statistically significant relationship with economic growth. Specifically, when lending rate increase by one percent, it generates 0.32% decrease in economic growth at 1 percent level of significance, all else being equal. Economically, high lending rate increases cost of borrowing which decreases investment and consumption thereby reducing economic growth.

The error correction term [ECM (-1)] illustrates the speed of adjustment which is negative and significant in our case confirming the existence of a long-run relationship between the dependent and the independent variables. The coefficient of the ECM is -0.4943 which suggests that co-integration and stability exist among oil resource rent, gas resource rent, exchange rate, foreign direct investment, lending rate and economic growth in the model. Thus, there is one percent significance level of stability in the model and equilibrium in the long-run would adjust by approximately 49% annually after any short-run shock.

Table 8 shows that the estimated NARDL model is free from econometric and statistical problems since all the probability values are greater than 0.05. Also the CUSUM and CUSUMQ graph (see figure 1 in the appendix) revealed that gross domestic product over the sample period is stable. This is so because the plots of the Cumulative sum and Cumulative sum of square (CUSUM and CUSUMQ) lie within the 5% critical bound.

## 9. Limitation and areas for future research

The major limitation of our study is the inability of the study to unpack the channels through which natural resources rent affects economic growth. Although our study focused on examining the direct effect of oil and gas resource rent on economic growth, we believe that there might be some potential pathways through which oil and gas resource rent affect economic growth. Hence, future researchers should focus on applying the appropriate methodology to examine the pathways through which oil and gas resource rent affects economic growth to aid in implementation and formulation sound policy for the economic progress of developing countries. Some potential channels might include institutional quality, financial development, labour productivity and others. Secondly, our study is a specific country case study which somewhat limit our findings. Although our study has yielded interesting findings, using panel model such as fixed effect model that account for specific error term and in country or regional differences such as differences in technological advancement, differences in production/supply capacity, differences in governance and institutional quality and among others might have outstanding results for the relationship between natural resource rent (oil and gas resource rent specifically) and economic growth. Hence, future studies must focus on undertaking a cross county studies in this regard.

## 10. Conclusions and policy recommendations

While a large body of literature presents evidence that oil resource extraction hurts developing countries (resource curse hypothesis), in this study, we found that oil resource rent spurs economic growth, supporting the resource blessing hypothesis. However, gas resource rent rather decreases economic growth, providing evidence in support of the resource curse hypothesis. These results are robust to suite of diagnostic and reliability checks. Similar conclusion can be drawn for other developing countries with similar socioeconomic and demographic setting like Ghana.

We used monthly time series data to examine the effects oil and gas resource rent on economic growth of Ghana, where empirical evidence appears to be relatively scanty. We used NARDL model as estimation strategy to account for the asymmetries in oil and gas resource rent, controlling for other relevant macroeconomic indicators that influences economic growth.

For the macroeconomic controls variables, our findings indicate that lending rate and exchange rate, clearly affect economic growth of Ghana. Given the negative relationship between lending rate and economic growth, the study recommends that central bank should closely monitor and collaborate with commercial banks to produce an effective strategy of reducing and stabilizing the lending rate over a long period of time to motivate firms, individuals and other institutions to borrow from banks in Ghana, especially commercial banks. This would increase investment to promote economic growth. For exchange rate, the study revealed that it exerts a negative impact on economic growth. Following this result from the study, we recommend that government, monetary authorities and other private institutions must work together to design policies that aim at stabilizing exchange rate over a long period of time.

Overall, our empirical findings provided evidence that natural resources rent (oil and gas resource specifically) affect economic growth asymmetrically. Thus, both oil and gas resource rents exert asymmetric effect on economic growth of Ghana. However, natural gas resource extraction is not considered as a significant positive contributor to economic growth of Ghana likely due to high volume of gas importation. These results suggest that currently it would be more beneficial for investment companies and firms to channel more resources and effort to expand oil resource firms than gas resource firms. This would increase the production and extraction of oil resources compared to gas resources which contribute significantly to economic growth. Thus, to promote economic growth of developing countries with similar socioeconomic and demographic setting like Ghana, firms and investors should channel enough resource and effort to extract more oil resources than gas resources. However, long-term policy interventions by government and investors should target establishing both domestic oil and gas resource firms to promote economic growth in the long run. Finally,

government and monetary authorities should promote policies that attract foreign direct investment inflow in Ghana while taming inflation and lending rate towards growth enhancing targets.

Our strength cometh from God . . . . .

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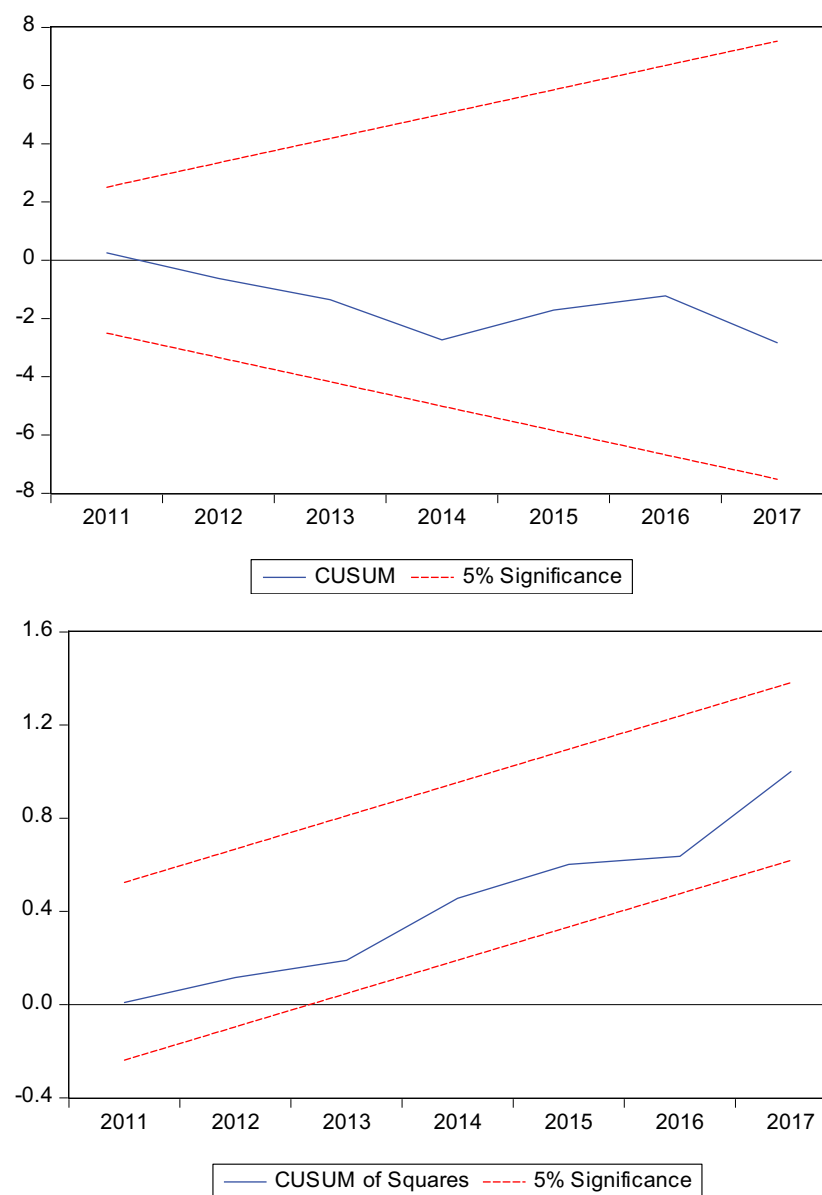
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## Appendix

**Figure 1. Plots of CUSUM and CUSUMQ.**





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